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SUBJECTIVE AND COMMUNITY WELL-BEING INTERACTION IN A MULTILEVEL SPATIAL MODELLING FRAMEWORK [1]

Włodzimierz Okrasa [2], Dominik Rozkrut [3]

ABSTRACT

Analysing the cross-level interaction between individual and community well-being requires a joint involvement of both 'vertical' and 'horizontal' perspectives. While multilevel modelling separates the effects resulting from personal characteristics from those resulting from community features, the need to account for spatial variation and geographic membership proves that space and place matter, too. In this paper, the explicitly-spatial multilevel model has been developed to this effect, namely to identify both types of effects, space and place-related, using the hierarchical (nested) data structure for the smallest administrative units – NUTS5/LAU2, i.e. communes (gminas). In their analysis, the authors employed two methods for measuring well-being: (i) individual (subjective) well-being measure derived from the nation-wide Time Use Survey data, which they occasionally replaced with 'life satisfaction' type of self-reported measures, and (ii) multidimensional index of local deprivation composed of eleven domain-scales. The spatial multilevel modelling has been extended by an attempt to assess what effect spatial interaction has on cross-level relationships. Its inclusion in the discussion with which this paper concludes seems recommendable, as it indicates the need for more systematic efforts towards a spatially-integrated approach to this kind of modelling problems.

Key words: spatial analysis, measuring subjective well-being, community deprivation, social capital.

1. Introduction

There are several reasons to analyse community and individual well-being jointly and, by the same token, to focus on the relationship between them, especially in the local development context. Several aspects of this relation have been recognized and discussed thoroughly in the literature, inspired among others by Stiglitz-Fitoussi-Sen (2009) report challenging the tradition of using

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[2] Cardinal Stefan Wyszynski University in Warsaw, and Statistics Poland. E-mail: w.okrasa@stat.gov.pl. ORCID ID: https://orcid.org/0000-0001-6443-480X.
[3] Statistics Poland. ORCID ID: https://orcid.org/0000-0002-0949-8605.

GDP as the main measure of social progress, along with concomitantly growing awareness of the significant role of subjective well-being in economic development (esp. sustainable development, e.g. Helliwell, et al., 2010) at both macro-level (although not in an unambiguous way, e.g. Easterlin, 2010), as well as in connection with community (e.g. Phillip and Wong, 2017).

In the employed modelling approach, an empirical application is preceded by discussion of the measurement and data issues, including the problem of creation an analytical multi-source database (through 'bottom up' integration of units from different surveys) and construction of the major well-being measures: (i) multidimensional index of local deprivation encompassing eleven components, each of them being constructed from public-use data file (Local Data Bank, Statistics Poland), using 'confirmatory' version of factor analysis (for all 2478 communes (gminas)), and (ii) individual (subjective) well-being measure derived from the nation-wide Time Use Survey, which is substituted in some contexts by self-reported measures from national surveys on Social Cohesion or Social Diagnosis.

An empirical application of the multilevel spatial modelling (which constitutes the major portion of the remaining part of the paper) is preceded by searching for main factors and auxiliary covariates affecting individual (subjective) well-being, while looking after the issue of endogeneity.

When expressed in a way analogous to the so-called basic 'life-satisfaction equation', subjective well-being might be treated as a function of residents' income and hours of work vis-a-vis the impact of community well-being (or deprivation) through employing a causal type of reasoning using path analytic version of the structural model. A path-analytic version of the structural model is employed to decompose total effect of the independent variable into the natural direct and indirect effects (Hong, 2015; Okrasa and Rozkrut, 2018).

Another important factor at the community level (referred often to social cohesion) is social capital, the relative impact of which - weighted against individual income - is checked using the 'compensating variation' approach. Social capital, indicated by the intensity of the third sector organizations' presence in a community, can be interpreted as the amount of money required to compensate a person for a possible loss in utility (for instance, like when price is rising). The 'compensating variation' approach to social capital allows one to identify the utility gain derived from a unit increase in social capital (Anand and Montovani, 2018; Okrasa, 2018).

Following exploration of spatial patterning, clustering and spatial dependence (using GeoDa procedures, Fischer and Getis, 2010) a direct assessment of the spatial interaction effect on the cross-level relationships is also attempted (Patuelli and Arbia, 2016) using flow-type data from between-community migration public statistics.

In the concluding section, a spatially integrated approach to vertical (multilevel) and horizontal (across areal units) relationships between individual (subjective) and group (community) measures of well-being is discussed towards elaborating a comprehensive methodological framework, as noted by Arcaya et al., (2012) who analysed area variations in health, accounting for spatial and membership processes simultaneously providing valuable insights (p. 824).

2. Methodology: operationalzation, data and models

The increased focus on well-being (along the *beyond-GDP* paradigm) results also in several guidelines and recommendations offered in the literature on the measurement of subjective well-being in public statistics, such as ONS Report (Dolan et al., 2011); OECD Report (2013, 2015), CNSTAT/Stone and Mackie (2014); Kalton et al. (2015). While there is a consensus regarding individual (subjective) well-being measures that they are supposed to cover all or some aspects of its triadic structure of subjective well-being – evaluation (e.g. *Satisfaction from Life); e*xperience (*How did you feel yesterday);* and eudaimonic (*Sense of Life)* – the community well-being measurement approaches still await similar elucidation (e.g. Kim and Ludvigs (2017)), although several country-specific approaches have been already well developed within public statistical systems (for instance, in Australia, Canada, USA, and UK).

2.1. Individual (Subjective) well-being: Time Use Survey/TUS data-based measures

Since psychometric, self-reported data-based measures of well-being are often criticized by econometricians for their arbitrariness and low reliability, data from time use surveys (collected with day reconstruction method/DRM) are being recommended instead - see Kahneman and Krueger (2006).

Amount of the time *h* spent by respondent on performing an activity with information on emotion (negative-neutral-positive) s/he was associating with this activity (as 'time in unpleasant state') can be reflected by the value of U-index (e.g. Krueger et al., 2009, p. 19):

$$\mathbf{U_i = \Sigma_j (I_{ij} h_{ij} / \Sigma_j h_{ij})} \text{ (in TUS conducted in 2013: I = -1. 0. +1)} \quad (1)$$

and

$U = \Sigma_i(\Sigma_j I_{ij}h_{ij} / \Sigma_j h_{ij}) / N$ for N-persons / group in population, interpreted as the average proportion of time that the members of the group spend in an unpleasant state.

Such an approach to measuring life satisfaction or happiness is not only more consistent with the concept of utility[4]. The lack of such an underlying concept makes some authors (e.g. Gibson, 2016) full of reservation towards the use of these measures. But it has a direct reference to the *capability approach* according to A. Sen's interpretation, who stresses that well-being should be conceived directly in terms of *functionings* and *capabilities* instead of resources or utility (e.g. Alkire, 2015). Time use data seems to be one of the most reliable source of information on functioning and capabilities.

2.2. Community Well-Being (CWB)

is a multifaceted and multilevel concept, hardly covered by standardized procedures of operationalization and measurement. It is a "concept developed by synthesizing research constructs related to resident's perceptions of the community, … needs

[4] For instance, Gibson (2016) maintained that there is no theoretical justification for maximizing either happiness or life satisfaction due to the fact that neither correspond to utility.

fulfilments, observable community conditions, and the social and cultural context…" (Sung and Phillips 2016:2 [in Phillpis and Wong 2017). The important features of CWB often include community cohesion (or local, spatial cohesion), which is interpreted here as any of the possible patterns of configuration of the economic cohesion and/or social cohesion and/or territorial cohesion (following Kearns and Forest (2001).

Both types of measures - individual and community well-being – constitute the main input of the Multi-source Analytical Database (MAD). It encompasses Multidimensional Index of Local Deprivation (MILD) for 2478 communes/gminas (NUTS5/LAU2), composed of eleven (pre-selected) domains of deprivation - each characterized by a number of original items: *ecology* – *finance* – *economy* – *infrastructure* – municipal *utilities* – *culture* – *housing* – *social assistance* – *labour market* – e*ducation* – *health* [65 items].

Other constitutive components of AMD are: Time Use Survey *(TUS2013)* and Social Diagnosis, an independent survey conducted bi-annually by a consortium of universities since 2003 to 2015 (12 352 households or 26 308 persons at age 16+), and data from EU-SILC (Survey of Income and Living Conditions, conducted on a regular basis in member countries of the European Union). Figure 1 presents the structure of MAD, where darkened centre marks the scope of data integrated in the following analysis.

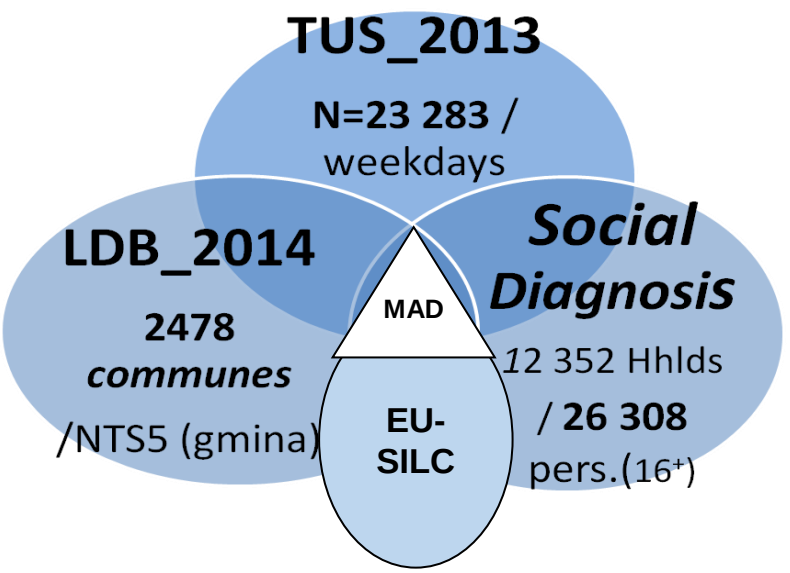

Figure 1. Multisource Analytical Database MAD

The data from Social Diagnosis survey allowed us to construct several compositional types of measures of community well-being. Specifically, measures of the level of *satisfaction* of residents – based on the percentage of 'satisfied' or 'very satisfied' on each of the five scales – were attributed to communes (in which at least 10 households were identified as included into the survey). The following

scales were built: (i) satisfaction with *living conditions*; (ii) satisfaction with *living environment;* (iii) satisfaction with *social and family relations*; (iv) satisfaction with *personal situation*, and (v) *disapproval of antisocial* behaviour.

2.3. Individual and community level factors of subjective well-being

Several working hypotheses implied by theoretical considerations or by the results of other research in the literature shown to be subject to verification on the ground of the above sketched MAD. Two of them are briefly checked here. One refers to the extensively discussed trade-off between income from earning and time spend on work (Clark 2018). The second hypothesis concerns the role of social capital in the face of a possible loss of income by household (Anand and Montovani, 2018).

Basic Well-Being Equation – hypothesis of income and time of work trade-off.

Approximation of the so-called in the literature basic well-being equation or 'life satisfaction equation' (e.g. Clark 2018) is made here with the following equation:

$$\text{Well-Being} = \beta_1 Y + \beta_2 h + \theta X + \varepsilon \tag{2}$$

where h – time of work; Y earning, and X also auxiliary covariates.

Results are in Table 1 (next section).

The role of social capital – compensating variation approach.
Complementary to the above considerations of work and earning trade-off the role of community's social capital can be tested using the so-called 'compensating variation ' approach (e.g. Anand and Montovani, 2018) .

Formally, a life satisfaction equation can be re-written as:

$$U^0(y^0, SC^0)=U^1(y^0+CV,SC^1) \tag{3}$$

where y is household income, SC stands for social capital, and CV for compensating variation (or CV for y), which can be obtained by identifying the utility gain derived from a unit increase in social capital. Accordingly, the expected utility given any particular value of social capital can be written as:

$$(U_i|SC_i,y_i,X_i) = \beta_0+\beta_y y_i+\beta_{sc}SC_i+\gamma' X_i+\varepsilon_i \tag{4}$$

where *X* represents all additional covariates.

Following Anand and Montovani (2018), CV can be defined as

$$CV=\beta_{SC} / \beta_{y.} \tag{5}$$

(see Anand and Montovani 2018 for details)

These two aspects of relation in which income remains, on the one hand, with time of work and, on the other, with social capital, can be arranged in a joint (extended) well-being equation, with social capital included into the set of predictors. Results are in Table 1.

2.4. Individual well-being and community well-being relationship - a multilevel modelling approach

In order to capture the effect of community for individual well-being, or the so-called membership process, multilevel modelling approach seems to be most appropriate (e.g. Arcaya et al., 2012, Okrasa, 2017). Ideally, it should employ hierarchically nested structure data, which is not the case of data in MADb, where for the selected communes/gminas, the group-level data are complemented by data derived from individual (household) level. However, it suffices to demonstrate the logic of the approach here, albeit with caution in interpretation of detailed results since formally admissible procedure applied to available data of official statistics can only provide an empirical illustration or argument for the appropriateness of such a modelling approach.

Having made the needed reservations, the following model was employed, using notations (e.g. Subramanian, 2010):

- y_{ij}, well-being of *i* individual in *j* commune/gmina;
- x_{1ij} predictor of individual – such as: age, education or satisfaction (e.g. from life in a community, family life, etc.)
- predictor of macro-level: *Multideminsonal Index of Local Deprivation* for j-commune/gmina /$MILD_j$

- Model for one-level regression: $Y_{ij} = \beta_{0j} + \beta_{1j} X_{1ij} + \beta_{2j} X_{2ij} + e_{ij}$ (6)

  Let y_{ij} stands for household disposable equivalised income:

  $$y_{ij} = \beta_{0j} + \beta_{1j}\, ability\text{-}to\text{-}meet\text{-}ends_{ij} + \beta_{2j} local\text{-}deprivation_{ij} + e_{ij}$$

  where: $\beta 0j$ – refers to $X0ij$ average score on a well-being scale in j-th commune/gmina (e.g. 'ability to meet ends', X_{0ij} =1);

  β_i – average differentiation of individual well-being associated with individual material status (X_{1ij}) across all territorial units (communes/gminas);

  e_{0ij} – residual term for the level-1.

- Two-level model to account for hierarchical data structure can be specified as two-level regression, to explain the variation of the regression coefficients

β_j through including the level of local deprivation *(alter. local development indicator* $Z_j \equiv MILD(2016)$*:*

$$\beta_{0j} = \gamma_{00} + \gamma_{01} Z_j + u_{0j} \tag{7}$$

and

$$\beta_{1j} = \gamma_{10} + \gamma_{11} MILD_j + u_{1j}$$
$$\beta_{2j} = \gamma_{20} + \gamma_{21} MILD_j + u_{2j}$$

Rearranging terms we obtain:

$$Y_j = \gamma_{00} + \gamma_{10} X_{1ij} + \gamma_{20} X_{2ij} + \gamma_{01} MILD_{jj} + \gamma_{11} X_{1ij} MILD_j + \gamma_{21} X_{2ij} MILD_j$$
$$+ u_{1j} X_{1ij} + u_{1j} X_{2ij} + u_{0j} + e_{ij} \tag{8}$$

– where w_{1j} is a 2-level predictor, i.e. the index of local deprivation, $MILD_{1j}$. Results are in Table 2.

2.5. Spatial aspects - checking for spatial dependence

Estimation of the spatial regression model parameters (notation for individual observation):

$$y_i = \rho \sum^{n}_{j=1} W_{ij} y_j + \sum^{k}_{r=1} X_{ir} \beta_r + \varepsilon_i \tag{9}$$

where: y_i – the dependent variable for observation *i*; X_{ir} *k* – explanatory variables r = 1. …. k with associated coefficient β_r; ε_i is the disturbance term; ρ is the parameter of the strength of the average association between the dependent variable values for region/observations and the average of them for their neighbours (e.g. LeSage and Pace. 2010. p. 357). The above specification of the spatial regression model assumes that ε_i is meant as the *spatially lagged* term – versus *spatial error* formulation - for the dependent variable (which is correlated with the dependent variable), that is: $\varepsilon_i = \rho W_i . y_i + X_{i.} \beta + \varepsilon_{i.}$ The latter type of model is used below to check *how* and *why* *'*place' and *'space'* matter.

3. Results

At a glance, results are generally in line with the hypotheses cited above.

As regards the impact of income vs. work time, there are opposite directions of influence of income and work time on well-being measured here by U-index. While greater income is positive for individual well-being (U-index decreases with growing income), the increased amount of time spent on work is negative (U-index increases). Question arises about the point of balance (trade-off between the two factors of well-being – see Kahneman and Deaton (2010) for comparison of the income effect.

Table 1. The *Well-Being Equation* extended by community cohesion – social capital – and individual-level variables

	Unstand. Coefficients		**Stnd. Coeff.**		
Predictors	**B**	**Std. Error**	**Beta**	**t**	**Sign.**
(Constant)	0.029	0.027		1.068	0.285
Job-time (main and additional)	0.004	0.000	**0.285**	24.630	0.000
Income of H'hold *pc* - monthly	-1.841E-05	0.000	**-0.087**	-6.987	0.000
MILD_2014 Local Deprivation	0.000	0.000	0.118	6.630	0.000
Subsidies Real < Simulated/fair	-0.011	0.002	-0.070	-6.887	0.000
Risk assoc. w/depr. Soc.Welfare	-0.036	0.002	-0.649	-15.626	0.000
Risk assoc. w/depr. Lab. Market	0.050	0.003	0.809	18.454	0.000
Ratio 'in-work' to 'not-in-work'	-0.010	0.001	-0.080	-6.900	0.000
Rural	-0.007	0.003	-0.030	-1.978	0.048
U-R mixed	-0.014	0.002	-0.074	-5.547	0.000
Trust in local authority	**-0.002**	**0.001**	**-0.032**	**-3.468**	**0.001**
Satisfaction with living place	-0.002	0.001	-0.017	-1.898	0.058

Adjusted R Square = 0.18; F (11, 10 095) 198.387; p< .000 **CV = -0.032/ -0.087** (= 0.37)

It is worth noting that the measures used here are not exactly of the same type as those analysed in the literature where, for instance, individual earning rather than average income per person in household is used. But, in spite of that the fact that results are consistent with other discussed in the literature confirms usefulness of such an approach, even when public statistics data are used (not necessarily fully comparable with other data).

The second question, concerning the relative impact of social capital vs. income, is also addressed in a simplified version as the former is presented here by positive declaration of trust in local authority. However, there is a substantial 'compensating' effect of the community social capital on individual well-being (acc. to U-index) - living in environment characterized by good relations between residents and public administration is indicative of a possibly cushioning effect for households vulnerable to income shock.

Cross-level relationships depend, however, on both individual and community level factors, and multilevel modelling.

The following model was calculated using also data from EU SILC, with household equivalised disposable income per person as an indicator of individual well-being:

$$Individual\ Well\text{-}Being_{H'hld\ eqv.\ disp.\ income} = \gamma_{00} + \gamma_{10}\ ability_{\_to\text{-}meet\text{-}ends} + \gamma_{20}\ time\text{-}on\text{-}job + \gamma_{01}\ MILD + \gamma_{11}\ ability_{\_tme} * MILD_j + \gamma_{21} time\text{-}on\text{-}job * MILD_j + u_{1j}\ ability_{\_tme} + u_{2j}\ time\text{-}on\text{-}job + u_{0j} + e_{ij}$$

It is assumed that such a specification of cross-level (between individual and community/gmina measures of well-being, with cross-level *interaction* effect, should ensure robust estimation (e.g. Subramanian. op. cit. p. 521; Hox et al. 2017).

Table 2. Multilevel regression of individual well-being – *household equivalised disposable income per person* – on community and individual level factors with interaction terms.

	Unstand. Coefficients		**Stand. Coeff.**		
Predictors	**B**	**Std. Error**	**Beta**	**t**	**Sign.**
(Constant)	9.687	0.425		22.784	0.000
Ability to 'meet the ends' (binary)	0.049	0.019	0.041	2.583	0.010
Time on job and commuting	0.028	0.016	0.280	1.698	0.090
MILD /Multidimensional Index of Local Deprivation (2016)	-0.023	0.005	-0.172	-4.199	0.000
Interaction "ability to meet the ends" and local deprivation (MILD2016)	0.003	0.000	0.414	26.174	0.000
Interaction "job-time" and local deprivation (MILD2016)	0.000	0.000	-0.275	-1.688	0.091

Adjusted R Square = .240; $F_{(df\ 5,\ 8496)} = 536{,}381$); $p < .001$

Negative effect of local deprivation (MILD for 2016), both in separation and in interaction with time spend on work – but not with ability to meet the ends, which may offset this effect in better-off households - contrasts with other factors having positive impact on the level of well-being measured here by the household equivalised disposable income. It confirms the role of place and overall quality of the living environment (commune) for individual well-being, which on the other hand significantly depends on such household or person level factors as time spend on work, including commuting.

Spatial autocorrelation and spatial clustering. Moran's I for the below maps (from the left): (a) I=0.20 for local deprivation (MILD); (b) I=0,09 for U-index; (c) I= 0,10 for U-index by MILD

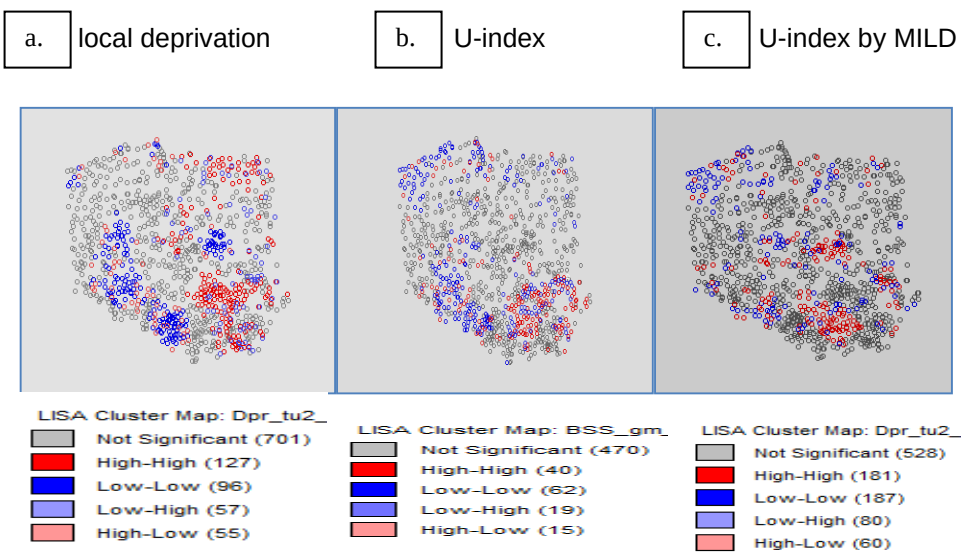

Figure 2. Spatial autocorrelation – Moran's maps

The spatial patterns of local deprivation and subjective well-being (both interpreted in 'negative' terms) show one important feature in common – they both tend to cluster around high or low values of each of these measures in a similar part of the country. In south-east, clusters of high deprived communes (panel a) and also of communes with residents high on the U-scale /'unpleasant state' (panel b) predominate. At the same time, the opposite spatial pattern prevails in the western (especially south-west) part of the country – in communes generally lower on the local deprivation scale live people with a higher level of well-being (lower level of dissatisfaction in the sense of the U-index). The joint spatial distribution of communes (gminas) according to both measures, U-index and MILD, is presented at the panel (c). The overall tendency to spatial concentration is consistent with separately characterized patterns.

It is worth mentioning here the result obtained using an alternative approach, called Functional Data, allowing for taking into account the spatio-temporal property of data and for comparing the spatial patterns of local deprivation (clusters) and subjective well-being for a long-term period (Krzyśko, Okrasa and Wołynski, 2019). The above identified patterns are shown to be even stronger in terms of the autocorrelation coefficient (Moran's I), following the same trends along the East-West geographic axes, and providing useful suggestions for practitioners and decision makers responsible for allocation of public resources

for improving both of these areas of concern, i.e. local development and individual well-being.

Table 3. Spatial dependence - spatial regression of Subjective Well-Being on commune's attributes and compositional characteristics

SPATIAL ERROR MODEL – MAXIMUM LIKELIHOOD ESTIMATION

Dependent Variable: ***U –index*** Number of Observations: 937;
Number of Variables: 8; Degrees of Freedom: 929; **Lag coeff. (Lambda): 0.43**;
R-squared: 0.12

Variable	**Coefficient**	**Std.Error**	**z-value**	**Probability**
Constant	0.523731	0.042847	12.2233	0.00000
Monthly income	-0.002730	0.001960	-1.40359	0.16044
Age_avg (%)	-0.014313	0.005653	-2.53177	0.01135 *
Education_hs+ (%)	0.000381	0.000222	1.71849	0.08571 *
Not working pop. (%)	-0.001304	0.000273	-4.77623	0.00000 *
Index of loc.depr.-ecology	0.000560	0.000462	1.21309	0.22510
Index of loc. depr._Soc. Welfare	-0.000415	0.000312	-1.32693	0.18453
Subsidies_pc	1.2323e-005	1.1588e-05	1.06344	0.28758
Lambda	0.431769	0.0677941	6.36883	0.00000

4. Discussion and Conclusion:

Research on individual and community well-being requires data from both individual and community level and both objective and subjective measures in order to explore effectively the relationship in which they remains, and are influenced by such crucial factors as community cohesion, including social capital. As the role of such factors is shown to be important in the local development context, their effects need to be taken into account in the policy about allocation of scarce resources among communes (gminas), especially during the hard time. It might be hopped that communes characterized by a given level of local deprivation but with a higher level of social capita and social cohesion are, on average, less vulnerable to external shocks and are more capable to arrange resources for endogenous, community-based development than others.

Bringing space into analysis gives insight into processes which actually take place on a larger scale than own community – spatial dependency confirms this, suggesting spatio-temporal analytical framework. In particular, for the purpose of rational policy design and evaluation. Individual well-being increases along with

greater household income. However, community deprivation reinforces significantly the subjective well-being effect of individual income. Also, deprivation in several domains shows a negative association with U-index (such as risk associated with deprivation in local social welfare).

Working with existing databases, e.g. public files of official statistics, has its advantages and disadvantages, which needs to be recognized to enhance integration procedures in constructing a multi-source analytical database. Nevertheless, geographically referred data provide a promising land of opportunities for policy analysis focused on well-being as the ultimate target of the local development.

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